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EXHAUST MANIFOLD

TECHNICAL FIELD

The present invention relates to a catalyst integrated  
5 exhaust manifold, and particularly to a structure of an exhaust  
manifold which is joined to a catalyst container with a tilt angle.

BACKGROUND ART

Various proposals have been made for catalyst integrated  
10 exhaust manifolds for the purposes of preventing interference of  
exhaust gas discharged from each discharge port of the engine to  
improve the engine output as well as efficiently cleaning exhaust  
gas.

For example, Japanese Laid-open Patent Application No.  
15 2001-164937 (paragraphs [0014] to [0019] and FIGS. 1-7) discloses  
a catalyst integrated exhaust manifold including a plurality of  
branch pipes communicating with corresponding discharge ports of  
an engine, an exhaust collecting portion where the plurality of  
branch pipes are joined integrally, a catalyst container joined  
20 to the exhaust collecting portion, and a catalyst accommodated in  
the catalyst container, wherein a partition wall is provided within  
the exhaust collecting portion so that the interior of the exhaust  
collecting portion is divided into two chambers, and the branch  
pipes respectively joined to the discharge ports of the cylinders  
25 that are not continuous in the order of exhaust processes are  
collected and communicated with each chamber.

Japanese Laid-open Patent Application No. 2000-110555 (paragraphs [0007] to [0011] and FIGS. 1-4) discloses a catalyst integrated exhaust manifold having a clearance between an exhaust downstream end edge of the partition wall, which divides the interior of the exhaust collecting portion into two chambers, and the catalyst such that a clearance area becomes not more than a predetermined rate of the exhaust passage cross-sectional area positioned at the exhaust downstream end edge of the partition wall to prevent interference of exhaust gas.

These catalyst integrated exhaust manifolds are intended for use in the type where the exhaust collecting portion is linearly joined to the catalyst container.

However, the exhaust collecting portion is often joined to the catalyst container with a tilt angle because of a problem such as engine layout.

In a catalyst integrated exhaust manifold 101 as illustrated in FIG. 6, an exhaust manifold 104 is jointed to a catalyst container 103 for accommodating a catalyst 102 with a tilt angle. The exhaust manifold 104 consists of a plurality of branch pipes 106 each joined to corresponding discharge ports of the engine via a discharge port flange 105, an exhaust collecting portion 107 where the plurality of branch pipes 106 are collected, and a partition plate 108 for dividing the interior of the exhaust collecting portion 107.

This kind of catalyst integrated exhaust manifold 101 has drawbacks such as deterioration of the catalyst 102 and disturbance

of smooth exhaust gas discharge because exhaust gas flows in a biased manner with respect to the catalyst 102 and always hits the catalyst 102 in certain areas of a plurality of gas flow passages 102a.

5       Further, this kind of catalyst integrated exhaust manifold 101 has a drawback in that each of the chambers divided by the partition plate 108 is provided with an O<sub>2</sub> sensor, thereby resulting increased manufacturing cost.

10       In view of the above, the present invention seeks to provide a catalyst integrated exhaust manifold of the type where an exhaust manifold is joined to a catalyst container with a tilt angle, and which can prevent both deterioration of the catalyst and retention of exhaust gas due to biased flow of exhaust gas.

15       The present invention also seeks to provide a catalyst integrated exhaust manifold which can decrease the manufacturing cost.

#### DISCLOSURE OF THE INVENTION

20       In a catalyst integrated exhaust manifold including an exhaust collecting portion divided by a partition plate, exhaust gas flows intermittently into the exhaust collecting portion so that a pressure difference causes between the chamber into which exhaust gas has been flowing and the opposite chamber into which exhaust gas has not been flowing. We therefore propose to disperse  
25       a flow of gas by using exhaust gas flowing from one chamber to the other due to a pressure difference caused between the chambers and

to prevent a large amount of gas from flowing into a catalyst at one time.

According to one aspect of the present invention, an exhaust manifold which is joined to a catalyst container for accommodating a catalyst with a tilt angle, includes: a plurality of branch pipes communicating with corresponding discharge ports of an engine; an exhaust collecting portion where the plurality of branch pipes are collected; and a partition plate dividing an interior of the exhaust collecting portion, wherein the partition plate is cut away at an end surface portion located toward the catalyst.

According to this exhaust manifold, providing a cut at the end surface portion of the partition wall that is located toward the catalyst allows part of exhaust gas that has flowed into each chamber divided by the partition plate to flow into the opposite chamber through the cut and thereafter to flow toward the catalyst. This can alleviate a concentration of the flow of exhaust gas at a certain region of the catalyst and prevent deterioration of the catalyst and retention of exhaust gas due to biased flow of exhaust gas.

According to the present invention, the aforementioned exhaust manifold may be provided with a sensor at the cut-away portion of the partition plate.

According to this exhaust manifold, because a sensor such as an O<sub>2</sub> sensor is positioned in the cut-away portion of the partition plate, it is not necessary to provide a sensor for each chamber, thereby decreasing the manufacturing cost. Exhaust gas

flowing to the opposite chamber through the cut-away portion of the partition plate contacts with and passes through the sensor positioned in the cut-away portion. Therefore, the sensor effectively detects a state (oxygen concentration, etc.) of the exhaust gas discharged from the respective discharge ports.

#### BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 explains a catalyst integrated exhaust manifold of a first embodiment to which an exhaust manifold according to the present invention is adapted, in which (a) is a sectional view of the catalyst integrated exhaust manifold, and (b) is a perspective view of a partition plate.

FIG. 2 is a sectional view taken along the line A-A of FIG. 1(a).

FIG. 3 explains a catalyst integrated exhaust manifold of a second embodiment to which an exhaust manifold according to the present invention is adapted, in which (a) is a sectional view of the catalyst integrated exhaust manifold, and (b) is a perspective view of a partition plate.

FIG. 4 explains a catalyst integrated exhaust manifold of a third embodiment to which an exhaust manifold according to the present invention is adapted, in which (a) is a sectional view of the catalyst integrated exhaust manifold, and (b) is a perspective view of a partition plate.

FIG. 5 explains a flow rate analysis for exhaust gas using an exhaust manifold according to the present invention, in which

(a) is a partly exploded perspective view of the exhaust manifold used in the experiment, (b) is a transverse section of an exhaust collecting portion explaining gas passage area, and (c) shows flow rate distribution at a center of the catalyst for exhaust gas respectively discharged from the discharge ports.

FIG. 6 is a sectional view of a conventional catalyst integrated exhaust manifold, in which an exhaust manifold is joined to a catalyst container for accommodating a catalyst with a tilt angle.

#### BEST MODE(S) FOR CARRYING OUT THE INVENTION

With reference to the attached drawings, a first embodiment of the present invention will be described below.

Firstly, a catalyst integrated exhaust manifold according to the first embodiment, to which an exhaust manifold of the present invention is adapted, will be described with reference to FIGS. 1 and 2.

The exhaust manifold according to this embodiment relates to an exhaust system of an inline four-cylinder engine.

As shown in FIG. 1(a), a catalyst integrated exhaust manifold 1 includes a catalyst container 3 in which a catalyst 2 is accommodated, and an exhaust manifold 4 joined to the catalyst container 3 with a tilt angle.

The catalyst 2 converts detrimental component contained in exhaust gas that is discharged from each discharge port E1, E2, E3, E4 of the engine into harmless component. The catalyst 2

carries a three-way catalyst for cleaning CO, HC and NO<sub>x</sub> on a surface of a one-piece cast carrier having a large number of gas flow passages in the form of a honeycomb cross section and consisting of ceramic or heat resistant steel foil.

5           The catalyst container 3 is for accommodating the catalyst 2 and is joined to the exhaust manifold 4 with a tilt angle.

          The exhaust manifold 4 includes a plurality of branch pipes 6a, 6b, 6c and 6d communicating with corresponding discharge ports E1, E2, E3 and E4 of the engine via a discharge port flange 5, an  
10   exhaust collecting portion 7 where the plurality of branch pipes 6a, 6b, 6c and 6d are collected, and a partition plate 8 dividing the interior of the exhaust collecting portion 7.

          The illustrated four-cylinder engine is formed such that when the cylinders are referred to as a first cylinder, a second  
15   cylinder, a third cylinder, and a fourth cylinder in the order from the left side of FIG. 1(a), ignition is made in order of the first cylinder, the third cylinder, the fourth cylinder, the second cylinder, and the first cylinder.

          As shown in FIG. 2, the exhaust collecting portion 7 is  
20   divided by the partition plate 8 into two chambers, that is, a first chamber 7A and a second chamber 7B. The branch pipes 6a and 6d communicate with the first chamber 7A and the other branch pipes 6b and 6c communicate with the second chamber 7B.

          The partition plate 8 is cut away to provide a cut 9 at one  
25   side of the end surface portion 8A located toward the catalyst 2.

-----The first-chamber 7A and the second-chamber 7B are communicated-----

to each other through the cut 9.

Reference numeral 10 indicates an O<sub>2</sub> sensor for detecting oxygen concentration in exhaust gas and carrying out a feed back control of the air/fuel ratio. ECU (not shown) controls, based on the detection value of the O<sub>2</sub> sensor, to increase the amount of fuel injection when the air/fuel ratio becomes lean (excessive amount of O<sub>2</sub>) and to decrease the amount of fuel injection when the air/fuel ratio becomes rich (lack of oxygen).

The probe portion of the O<sub>2</sub> sensor 10 positions at the cut portion of the partition plate 8 so that the oxygen concentration of the exhaust gas that is discharged from each discharge port can be detected effectively.

Because the feed back control of the air/fuel ratio is carried out with the use of a single O<sub>2</sub> sensor in the illustrated example, the cylinder currently combusting is discriminated, for example, with a crank angle sensor (not shown) and a cam angle sensor (not shown), and an appropriate control is performed for increasing or decreasing the amount of fuel injection relative to a particular cylinder. Discrimination of the cylinder is not limited to the above example using a crank angle sensor and a cam angle sensor, and any other known methods can be used.

Operation of the catalyst integrated exhaust manifold 1 constructed as above will be described with consideration of a flow of exhaust gas.

According to the engine of this embodiment, ignition is made in order of the first cylinder, the third cylinder, the fourth



cylinder, the second cylinder, and the first cylinder. For this reason, combustion gas within the combustion chamber is discharged in order from the first discharge port E1, the third discharge port E3, the fourth discharge port E4, the second discharge port E2, and the first discharge port E1. The exhaust gas flow discharged from the first discharge port E1 flows down the branch pipe 6a of the exhaust manifold 4, and through the first chamber 7A of the exhaust collecting portion 7 it flows into the catalyst 2. Next, the exhaust gas flow discharged from the third discharge port E3 flows down the branch pipe 6c of the exhaust manifold 4, and through the second chamber 7B of the exhaust collecting portion 7 it flows into the catalyst 2. The exhaust gas flow discharged from the fourth discharge port E4 flows down the branch pipe 6d of the exhaust manifold 4, and through the first chamber 7A of the exhaust collecting portion 7 it flows into the catalyst 2. Further, the exhaust gas flow discharged from the second discharge port E2 flows down the branch pipe 6b of the exhaust manifold 4, and through the second chamber 7B of the exhaust collecting portion 7 it flows into the catalyst 2.

In this instance, part of the exhaust gas flows that flow from the branch pipes 6a, 6d into the catalyst 2 through the first chamber 7A are flowed to the second chamber 7B through the cut 9 of the partition plate 8 and then into the catalyst 2. Similarly, part of the exhaust gas flows that flow from the branch pipes 6b, 6c into the catalyst 2 through the second chamber 7B are flowed to the first chamber 7A through the cut 9 of the partition plate

8 and then into the catalyst 2.

As described above, according to the catalyst integrated exhaust manifold of this embodiment, providing a cut 9 at one side of the end surface portion 8A of the partition plate 8 located toward the catalyst 2 allows part of the exhaust gas flowing into the chambers 7A, 7B that are divided by the partition plate 8 to flow into the opposite chamber 7B, 7A through the cut 8 and then toward the catalyst 2. Therefore, even in the case where the exhaust manifold 4 is joined to the catalyst container 3 with a tilt angle, it is possible to alleviate a concentration of the flow of exhaust gas that flows from each chamber 7A, 7B into the catalyst 2 only at a certain region of the large number of gas flow passages of the catalyst 2, thereby preventing deterioration of the catalyst 2 and retention of exhaust gas due to biased flow of exhaust gas.

Further, because the O<sub>2</sub> sensor 10 is positioned in the cut-away portion of the partition plate 8, it is not necessary to provide an O<sub>2</sub> sensor 10 for each chamber 7A, 7B, thereby decreasing the manufacturing cost of the catalyst integrated exhaust manifold 1.

The amount of exhaust gas that flows to the opposite chamber 7A, 7B through the cut 9 of the partition plate 8 increases in proportion to the opening area of the cut 9. Meanwhile, increasing the opening area of the cut 9 may cause an interference of the exhaust gases that flow through the cut 9 from the discharge ports E1, E2, E3, E4 of which order of exhaust processes is continuous.

~~For this reason, it is preferable to set a proper opening~~

area of the cut 9, for example, by taking into consideration of the mount angle of the exhaust manifold 4 relative to the catalyst container 3, that is, the angle of the exhaust gas flowing from the exhaust collecting portion 7 to the catalyst 2.

5       Next, a second embodiment of the present invention will be described with reference to FIG. 3. Parts similar to those previously described with reference to the first embodiment are denoted by the same reference numerals, and detailed description thereof will be omitted.

10       As shown in the figure, a catalyst integrated exhaust manifold 11 according to this embodiment has substantially the same construction as the catalyst integrated exhaust manifold 1 according to the first embodiment. However, the partition plate 8 is cut away to provide cuts 9 at both sides of the end surface  
15       portion 8A of the partition plate 8.

      According to this catalyst integrated exhaust manifold 11, because the partition plate 8 is provided with cuts 9 at both sides of the end surface portion 8A, it is possible to more uniformly distribute a biased flow of exhaust gas toward the catalyst 2.

20       The amount of exhaust gas that flows to the opposite chamber through the cuts 9, 9 increases in proportion to the total opening area of these cuts 9, 9. Meanwhile, increasing the total opening area of these cuts 9, 9 may cause an interference of the exhaust gases that flow through the cuts 9, 9 from the discharge ports E1,  
25       E2, E3, E4 of which order of exhaust processes is continuous.

For this reason, it is preferable to set proper opening areas.

of these two cuts 9, 9, for example, by taking into consideration of the mount angle of the exhaust manifold 4 relative to the catalyst container 3, that is, the angle of the exhaust gas flowing from the exhaust collecting portion 7 to the catalyst 2.

5       Next, a third embodiment of the present invention will be described with reference to FIG. 4. Parts similar to those previously described with reference to the first embodiment are denoted by the same reference numerals, and detailed description thereof will be omitted.

10       As shown in the figure, a catalyst integrated exhaust manifold 21 according to this embodiment has substantially the same construction as the catalyst integrated exhaust manifold 1 according to the first embodiment. However, the partition plate 8 is provided with a cut 9 at the opposite side of the O<sub>2</sub> sensor 10, and a clearance 12 is formed between the end surface portion 8A of the partition plate 8 that is located toward the catalyst 2 and the upper surface of the catalyst 2.

20       Further, a recess 13 is provided at a position corresponding to the probe portion of the O<sub>2</sub> sensor 10. The probe portion of the O<sub>2</sub> sensor 10 is in the shape of a cylinder which is in conformity with the recess 13 of the partition plate 8.

25       According to this catalyst integrated exhaust manifold 21, because of the cut 9 provided at one side of the partition plate 8 and the clearance 12 formed between the end surface portion 8A of the partition plate 8 and the upper end of the catalyst 2, it is possible to more uniformly distribute a biased flow of exhaust

gas toward the catalyst 2.

The amount of exhaust gas that flows to the opposite chamber through the cut 9 and the clearance 12 increases in proportion to the opening area of the cut 9 and the clearance 12. Meanwhile, increasing the opening are of these cut 9 and clearance 12 may cause an interference of the exhaust gases that flow through the cut 9 and the clearance 12 from the discharge ports E1, E2, E3, E4 of which order of exhaust processes is continuous.

For this reason, it is preferable to set proper opening areas of these cut 9 and clearance 12, for example, by taking into consideration of the mount angle of the exhaust manifold 4 relative to the catalyst container 3, that is, the angle of the exhaust gas flowing from the exhaust collecting portion 7 to the catalyst 2.

#### ANALYSIS EXPERIMENT

With the use of an exhaust manifold according to the present invention, experiment was made for analyzing how the exhaust gas discharged from each discharge port flows to the catalyst.

FIG. 5 explains a flow rate analysis for exhaust gas using an exhaust manifold according to the present invention, in which (a) is a partly exploded perspective view of the exhaust manifold used in the experiment, (b) is a transverse section of an exhaust collecting portion explaining gas passage area, and (c) shows flow rate distribution at a center of the catalyst for the exhaust gas respectively discharged from the discharge ports.

The analysis experiment was carried out with the use of an

inline four-cylinder engine and with the engine speed kept at 3000 rpm. The analysis experiment was carried out to measure the flow rate of exhaust gas at a center part (line A-A) of the catalyst 2 at a time when exhaust gas flows out from each discharge port E1, E2, E3, E4.

The catalyst integrated exhaust manifold shown in the figure is constructed such that the partition plate 8 is provided with a cut 9 at one side of the end surface portion located toward the catalyst, and an O<sub>2</sub> sensor 10 is positioned in the cut 9 portion. A clearance (not shown) is also formed between the end surface portion of the partition plate 8 and the upper surface of the catalyst 2.

Herein, the area of the cut 9 is set to be 18% of one gas passage area PA or the other gas passage area PA at the lower end of the exhaust collecting portion 7 (one half of the area that is obtained by excluding the transverse cross-sectional area of the end surface portion of the partition plate 8 from the transverse cross-sectional area of the lower end of the exhaust collecting portion 7). When the cross-sectional area of the O<sub>2</sub> sensor 10 is included, the opening area of the cut portion becomes 15% of the gas passage area.

With reference to FIG. 5(c), it can be understood that part of the exhaust gas discharged from each discharge port E1, E2, E3, E4 flows to the opposite chamber through the cut 9 and thereafter flows into the catalyst 2.

Therefore, it is possible to distribute part of the exhaust

gas that flows through each chamber to the opposite chamber, so as to prevent deterioration of the catalyst 2 and retention of exhaust gas due to biased flow of exhaust gas.

While the present invention has been described in detail with  
5 reference to specific embodiments thereof, it will be apparent to one skilled in the art that various changes and modifications may be made without departing from the scope of the claims.

For example, the above-described catalyst integrated  
exhaust manifolds 1, 11, 21 have been described as of a 4-2-1  
10 exhaust system for use in a four-cylinder engine. However, it may be adapted to a 6-2-1 exhaust system for use in a six-cylinder engine.

Further, it may be possible to arbitrarily change the position, the number, the opening area of cuts 9 provided in the  
15 partition plate 8 and/or the area of the clearance 12 formed between the end surface portion 8A of the partition plate 8 located toward the catalyst 2 and the upper end of the catalyst 2, etc. For example, a cut 9 may be provided at a center of the partition plate 8 or at a center of the end surface portion 8A.